[Proc. Roy. Soc. Victoria, 24 (N.S.), Pt. I., 1911.]

Art. VIII.—*The Origin of Cuts on Bones of Australian Extinct Marsupials*

By BALDWIN SPENCER, C.M.G., M.A., F.R.S.,
Hon. Director, National Museum, Melbourne,

AND

R. H. WALCOTT, F.G.S.,
Curator of the Geological and Ethnological Collections, National Museum.

(With Plates XXXVI.-XXXIX.).

[Read 11th May, 1911].

In this paper we propose to deal with a series of bones showing cuts and incisions of various descriptions, our main object being to discuss the agency or agencies responsible for the production of these cuts and incisions. The bones have been derived from three different localities in Victoria—viz., (1) Perjark Marsh, (2) Buchan, (3) Lake Colongulac.

1.—The Pejark Bones.

The specimens from this locality were obtained during a special search made on behalf of the National Museum, Melbourne, in December, 1909, in the hope of securing additional evidence of the antiquity of man in Victoria, Mr. A. J. Merry, of Terang, some time previously having discovered under the volcanic tuff at that place an aboriginal stone implement,[1] together with fragments of bone, which he generously presented to the Museum.

Before dealing with the bones themselves, it will be well to give an account of the deposits of Pejark Marsh. This is rendered more necessary, as hitherto little was known concerning the relationship of the various associated beds, the nature of the bone bed itself, and the mode of occurrence of the bones in the various localities in the south-west part of Victoria where mammalian remains have been found.

1 This discovery has not yet been described.

Pejark Marsh, which is of some considerable extent, occupies a slightly depressed area of country lying mostly to the east of the road running due north from Terang township to Mount Noorat, in the county of Hampden, and was, it is said, originally covered with a thick growth of tea-tree scrub and eucalypts. A channel was made about twenty years ago to drain the Marsh, and the water is carried by a culvert under the Noorat road at a point just about a mile distant from the Terang post office. It was here and at several places for a quarter of a mile along the channel to the west that our excavations were made. Near the culvert a shaft showed some three feet of heavy black alluvial soil, eighteen inches of volcanic tuff, and five feet of black clay, passing into a yellow clay. The black clay is not clearly defined from the underlying yellow clay, but blends into it, unlike the volcanic tuff, which is sharply marked off from the soil above and the black clay below, and stands out like a ledge in parts of the drain where the clay has fallen away from beneath it.

Just at the junction of the two clays the majority of the bones occurred, including all the larger pieces, for practically the whole of the specimens are fragmentary. About a quarter of a mile west of the culvert the black clay bed becomes thinner, and near the bottom of it, and apparently immediately over the yellow clay, a black nodular cement makes its appearance; and just above it, in its surface layer, were a few fragments of bones, blackened by manganese oxide where they had been enclosed in the cement. In the excavations near the culvert the proximity of the yellow clay was generally indicated by the presence of a few hardish, brown, ironstone nodules. At a depth of three and a-half feet in the yellow clay, and about thirteen feet from the surface, the clay became harder, and red in colour. Sinking then became too difficult, on account of water, and a crowbar was driven down in the bottom of the cut.

At three feet the bar entered a softer stratum, from which water freely flowed through the hole made by the bar, showing that the water-bearing bed from which the residents obtain their supplies had been pierced. What that bed consists of could, therefore, not be ascertained, but, presumably, it is the soft fossiliferous limestone seen along the shores of Lake Keilambete, situated some two and a-half miles to the west, and which belongs to the marine tertiary series underlying the greater part of the volcanic areas of the Western District of Victoria. The black clay occurring under the tuff is highly carbonaceous, and this character, together with the frequent occurrence of what seem to be root cavities lined with a thin and hard ferruginous casing, and the constant presence of impressions of coarse grass-like leaves in the lowest layers of the tuff bed, denote the existence at a former period, as in historical times, of a swamp supporting a heavy growth of vegetation. In the upper part of the yellow clay are also seen fine black fibrous impressions left by the rootlets sent down by plants growing in the old swamp soil. The only foreign bodies found in the black clay besides the bone fragments were a few scattered quartz pebbles and a pebble of decomposed dolerite.

The tuff, or "sandstone," as it is invariably called locally, where measured, has a thickness varying from fifteen inches to two feet, and, as nearly as could be ascertained, occurs under a depth of from two to three feet of soil. It is calcareous, fine-grained, tough, and fairly even in its texture, but distinctly bedded. Its mineralogical character seems to be similar to the tuffs found elsewhere in the neighbourhood. In it were identified by Mr. F. Chapman, Palaeontologist to the National Museum, fresh-water diatoms, giving additional evidence that the tuff was laid down in an old swamp or lagoon; and still further palaeontological evidence was afforded of this fact by the discovery of the cast of a "yabbie" (*Engaeus sp.*) seemingly similar to those existing in the Pejark Marsh at the present day. Something may also be said about the yellow clay, as there are some points of interest in connection with it which may aid in determining its origin, and which, later, may be of use in correlating this bone bed with others in the district.

The first thing noticed was that the physical condition of this clay was quite different from that of the black clay above it. Instead of being tenacious and coming up in solid lumps, it broke into small pieces when dug into by the shovel. Again, it was not compact, but porous, and samples in drying showed a tendency to crack along indistinct lines of bedding. In the dry state it was very friable, and, on being placed in water, rapidly disintegrated.

After washing away the lighter clayey material, the residue—of which there was a fair quantity—consisted for the most part of quartz. By the naked eye a few black and bright-green particles could be picked out of the clay, and both these showed, the latter very sparingly, in the residues after washing. Among the black particles some were transparent and brown under the microscope, and could be referred to augite. Most of them, however, were quite opaque, with dull surface and glassy fracture. These appear to be a variety of spinel, probably pleonaste, and not picotite, as no chromium was detected. The bright-green particles are, no doubt, chrome-diopside, a mineral associated with the granular olivine, occurring as nuclei of volcanic bombs and as ejected blocks round some of our newer crater hills. Colourless zircons and a few grains of yellowish olivine are also present. The red patches found at a depth of about three feet or more in this clay have apparently been enriched in their iron contents by the leaching of the upper part of the bed, and the iron so introduced has taken the form of minute concretionary pellets of limonite. The general character of the clay and its contained minerals point strongly to it being a volcanic tuff, in all probability laid down on the tertiary rocks before the subsidence took place which created the depression now occupied by swamp lands.

The bones found at Pejark Marsh are, as mentioned, almost entirely of a fragmentary nature, only three or four toe bones being complete. They occurred principally just at the base of the black clay where it merges into the yellow clay below, while a few, but always very small in size, were scattered higher up in the former, a fact proving that they must have sunk through that part of the old swamp soil formed before the time of their deposition.

We were at first, more especially perhaps as the aboriginal implement was of the nature of an anvil or pounding stone, disposed to attribute to human agency the fragmentary condition of the bones forwarded by Mr. Merry; but further consideration and the securing of a larger collection have caused us to modify this opinion. We also thought that the place where the bones and implement were found was probably once the site of a camp by the side of a lagoon or marsh, but our investigations on the spot led us seriously to doubt this original surmise. In the first place the bones in the patches disclosed were not accompanied by the concomitants of an aboriginal camp, and, more important still, many of the fragments obtained showed unmistakable evidence of the fact that some powerful predatory animal had been at work on them.

The most striking feature in connection with them is the peculiar fragmentary nature of almost all the specimens, which vary in length from 12-170 mm., only one, however, attaining anything like the latter dimensions. Even such teeth as were found, were, with the few exceptions mentioned below, broken into small fragments and scattered through the clay.

Amongst the bones the only perfect specimens consist of two phalanges, but three others are nearly complete. Besides these, there are four more specimens sufficiently perfect to permit identification. They are all parts of metatarsals, two being the proximal ends of the fourth metatarsal of individuals of the genus *Macropus*, the larger agreeing in size with that of *M. titan*, and the smaller with those of our largest living kangaroos. One of the other two is the distal end of a fifth metatarsal of the size of that of *Palorchestes azael*, the other being somewhat smaller. All of the bones are mature. In addition to these, two molar and two incisor teeth of a small wombat were found, but not in direct association with other bones, and a claw bone remarkable for its large size and lateral compression. From the merest cursory examination it is obvious that the fragmentary condition of the specimens is not due to natural causes. If man had broken the bones to obtain the marrow—and there is no evidence to show that there could have been any other reason for his breaking them—three things would be noticed.

In the first place percussion marks would be present. Next, the bones would be completely broken up, more particularly longitudinally, to enable the marrow to be readily extracted. Lastly, only those which contained marrow would be treated in this manner.

In only one instance can any indications whatever be seen of marks which might be attributed to a natural stone or stone implement, such as would be used by the natives for bone-breaking. On one edge of the specimen referred to there is the appearance of its having received a blow which has struck off a fairly large conchoidal flake from the interior of the fragment. As this has taken place subsequently to the longitudinal fracturing of the bone, it could not have been made to get at the marrow. The bones certainly have been broken up very effectively, and in a longitudinal direction in nearly every instance, very few, not more than three or four specimens, being fractured in a transverse direction only. The longitudinal fracture, however, is not confined exclusively to bones and parts of bones containing marrow, for the solid distal end of a large femur (Plate XXXVI., Fig. 2) has been broken through quite apart from the shaft, and two small jaw bones (one of which is seen in Plate XXXVI., Fig. 14) are also cleanly split from end to end through the teeth sockets, which explains the fact that teeth, often themselves fractured, were met with, scattered through the clay bed. Fig. 13, Plate XXXVI., is the dorsal portion of the proximal phalanx of the fourth toe of a large extinct kangaroo. It has evidently been sundered lengthwise from a bone similar to Fig. 12, Plate XXXVI. Then, finally, there is the large fragment of a solid, massive bone (Fig. 1, Plate XXXVIII.) discovered by Mr. Merry close to the stone implement, broken longitudinally, approx imately in half.

It appears certain that, in the case of the great majority of the specimens, the bones were not broken by human beings with the object of getting at the marrow, and we must therefore seek for some other explanation of the way in which they have been fractured.

Many of the bones give no clue at all as to how they were broken, but, on the other hand, there are, on certain of them, marks of such a nature that we think they could only have been made by the teeth of carnivorous animals; and this has led to the most serious doubts being entertained as to the human origin of any of the cuts or marks on the bones.

Mr. C. W. De Vis (6), in his paper, "On Tooth-marked Bones of Extinct Animals," says, "About five per cent. of some hundreds of bones from the Darling Downs awaiting examination, are pitted, scored, cracked, chopped and crushed by the teeth. They have in fragments passed with the faeces through the intestines of bone-eating beasts of prey. Fully eighty per cent. of the remainder tell, in this splintered fragmentary condition, the same tale of violence."

Surface Incisions and Cuts.

On the greater number of specimens fine incisions and cuts of varying shape and length are scattered, sometimes thickly, all over the external surface of the bone. In many cases they convey the impression that the whole surface of the bone has been scratched by some sharp-edged or pointed implement. They vary in shape from a straight line to a curve similar to that of a boomerang. The short, straight, chisel-like incisions are, as a rule, terminated abruptly at one end, where the incision is deepest, as are also some of the longer ones. These short incisions are seen in specimen Fig. 2, Plate XXXVI., the fractured head of a femur, and several of them immediately adjoin and are parallel to the lines of fracture. In one or two cases they terminate in a slightly marked bifurcation.

The shallow surface incisions, as a general rule, occur in large numbers when they are present at all. In addition to these there are (Figs. 10, 11, Plate XXXVI.) more definite cuts, or gashes, of a V or wedge-shaped form in cross section, which have penetrated the bone to a greater depth than in the case of the ordinary incisions, but they are comparatively seldom met with. In some cases (as in Fig. 8, Plate XXXVI.) the cut has been made at such an angle that it has resulted in removing a slice from the bone surface.

Cuts Penetrating the Bone, and Resulting in Fracture.

In the large collection of bones, every bone save two phalanges being in a fractured condition, there are a certain number of special interest, because the nature of their fractures affords, we believe, a clue to the way in which these were produced.

Some few of the bones (such as Figs. 12, 15, 16, Plate XXXVI.) have fractures displaying no features of such a nature as to suggest that they have been produced by any special agency. The tooth, for example, of any animal strong enough for the purpose, might have caused such a fracture as any one of these shows. On the other hand certain bones are fractured in such a definite way as to indicate that they have all been subjected to similar treatment by some special agency. A very good example is seen in Fig. 4, Plate XXXVII., which we may take as typical of the cuts with which we are now dealing. The fragment of bone measures 52 mm. in length, 17 mm. in width, and 6 mm. in thickness. It has been cut through longitudinally, as if by a pair of curved shears, the edge of the bone showing no broken fracture. The clean cut, which has a very characteristic form, slopes slightly, and its exact shape may be seen by reference to the figure. In some instances the original cut has been continued by a line of fracture along the length of the bone, as, for example, is probably the case on the right side of the Fig. 7, Plate XXXVII., and when this occurs it would be naturally impossible to say exactly where the cut ends and the fracture begins, more especially as most of the bones are slightly weathered. The cuts on Figs. 5, 6, Plate XXXVII., which are respectively 5 and 7 mm. in thickness, agree very closely indeed with the one above described (Fig. 4, Plate XXXVII.), and it is quite evident that they have all been made by the same agency.

In other bones—as for example, Figs. 8, 9, 10, Plate XXXVII., and many others—the edges of the bones show, not what appears to be one single cut, as in the first-mentioned specimen, but a considerable number, as many as nine in Fig. 8, Plate XXXVII. The cuts, in some instances, as in Fig. 10, Plate XXXVII., are so directed as to give the bone a pointed end. Other bones, as in Figs. 13, 14, 17, Plate XXXVII., have a terminal diagonal cut, producing again a pointed end. Fig. 12, Plate XXXVII., is of the same type, but evidence of three cuts is very plain. Fig. 14, Plate XXXVI., and Figs. 17, 18, 19, Plate XXXVII., show very characteristic concavities, as if the bone had been partly cut and then fractured along a curved line. The bone represented by Fig. 18, Plate XXXVII., shows an even and regular concavity on its inner side. On the outside, as seen in the figure, this concavity is confined to only half the thickness of the bone, the exterior half being broken into a large and more irregular curve. In Fig. 17, Plate XXXVII., the contour of the cavity is quite regular; one end has been fractured by a diagonal cut. Fig. 19, Plate XXXVII., has two concavities, one on each side of the bone, one slightly in advance of the other. The curves of these concavities are much smaller than in the other specimens; one, particularly, seems as if it had been formed by several blows or applications of some instrument, by which small pieces were broken out, leaving a somewhat jagged edge. From the deepest part of this concavity towards the pointed end of the specimen, the thin outside layer of the bone has been removed, and its margin is similarly defined by scallops. The shape of the pointed end is due to cuts.

Fig. 14, Plate XXXVI., is a longitudinal section of the left ramus of a kangaroo jaw.

Origin of the Incisions and Cuts.

In regard to the smaller incisions, it must be pointed out that, though these are such as to produce a general scratched appearance of the surface on which they occur, a large number of them cannot, strictly speaking, be called scratches, if by a scratch is meant an incision made by drawing a pointed implement, such as a needle or tooth, over some surface. Some of the fine markings may be due to scratches, but in many of them the incision, seen under a magnifying power, is not symmetrical, and conveys the idea of having been made by a cutting edge, sometimes of considerable length. Further, a very characteristic feature is that they are curved (in many instances boomerang shaped), whereas, if they were true scratches, they would more naturally approach a straight line in form. The question arises whether they have been produced naturally by attrition or artificially. That the former is not the case, their very irregular arrangement and almost uniformly curved shape seem to prove conclusively. We have, therefore, to search for some artificial agency, and since from their nature it is highly improbable that they were caused by man, the agency must be found in some other predatory animal.

It will suffice now to say that we believe this animal to have been *Thylacoleo*, the evidence in favour of which we will proceed to bring forward in connection with the discussion of the question of the origin of the larger cuts.

In many cases the fractures are of such a nature that they might have been produced by the teeth of any such strong predatory animal, as the *Dingo, Thylacine* or *Sarcophilus;* that is, leaving *Thylacoleo* out of the question, we have animals which lived in Victoria in those ancient times quite equal to the task of merely fracturing the bones. It is, however, in the bones showing cuts which, at first sight, would appear to be almost without doubt due to human agency, that interest centres. In regard to them it may be said at once that they have been made either by man or by the bone-eating *Thylacoleo carnifex*. No *Dingo*, *Thylacine* or *Sarcophilus* could possibly produce such cuts.

As far back as 1859, Owen (16) published his well-known memoir on *Thylacoleo*, in which the skull was described for the first time, and in which also the characteristic premolar was stated to be adapted for piercing, holding and lacerating, like the canine of a carnivore. Owen's conclusions as to the nature and affinities of *Thylacoleo* were stoutly contested by other workers, notably by Falconer (8), Flower (9), and Krefft (10), all of whom came to the conclusion that the animal was, in the main, a vegetable feeder, and that the great cutting pre-molar was simply an exaggerated form of the same tooth molar was simply an exaggerated form of the same tooth present in the herbivorous *Hypsiprymnus* (=*Potorous*), one of the so-called rat-kangaroos. At a later period Owen was supported by McCoy (14), De Vis (6), and Broome (2), and it is generally admitted now that he was right, and that *Thylacoleo* was carnivorous in its habits.

Mr. De Vis on three occasions has referred to the bone-cutting power of *Thylacoleo*. In 1883 (6) he published his paper —previously referred to—" On Tooth-marked Bones of Extinct Marsupials," describing the occurrence on Darling Downs of large numbers of bones that had been broken up by predatory animals, instancing especially one of *Macropus affinis*, which bore the mark of the teeth of *Thylacoleo*. In 1900 (4) he published a paper, " The Bones and Diet of *Thylacoleo*," in which he described and figured first the ulna of a large kangaroo with cuts upon it, in regard to the making of which he says, " The only two capable instruments known to me are the tomahawk and the tooth of *Thylacoleo*." He also figures other bones bearing the marks of some strong cutting object, and, amongst them, the mandible of a young kangaroo that " has been crushed inwards and downwards so that a deep and well-defined area of impression has been left, and that impression is a mould in the soft bone, of the surface of the tooth of a young *Thylacoleo*. On the inner side opposite to this is another impression, but shallower and with irregular vertical ridges and groovings, just as clearly produced by the opposite tooth of the same jaw."

Mr. De Vis (5) also deals with the bone-cutting capacity of *Thylacoleo* in connection with the cuts on what is usually known as the "Buninyong Bone."

We have already referred to man as a possible agent in shaping the bones. That a good reason for breaking the bones might be found in his desire to obtain the marrow from them is apparent, and many bones in the collection favour this view, but the process is such a simple one that it is unlikely a sharp edged cutting implement, presumably made of stone, would be employed. Even if it were brought into requisition the force sufficient to produce cuts of the kind under consideration by one or two heavy blows with a stone axe, having what would be to us a blunt edge, would, almost certainly, simply smash the bone, leaving the only evidence of the nature of the implement used in the form of a surface cut along the line of fracture. Besides this, heavy blows from a straight-edged stone axe could not possibly have cut out the characteristic curves illustrated in Fig. 4, Plate XXXVII. That curves could be cut out by an axe by continuous and careful chipping is quite within the range of probability, but Fig. 8, Plate XXXVI., and Fig. 1, Plate XXXVII., give very good reason for believing that chipping in the manner adopted by man with a stone implement had not been resorted to. In these we have the most interesting of all the specimens, for they afford unquestionable evidence that the bones have been cut, and neither chipped nor ground, and, if this be so, we may reasonably conclude that the cutting through out has been executed by the one agent and by the same means. The importance, therefore, of discovering the maker of the cuts in these two specimens is obvious, for in it lies the solution of the whole problem. To take Fig. 8, Plate XXXVI., first—a small fragment of a large limb bone, about 15 mm. from its broad end, on its outer and convex surface, a roughly crescent-shaped shallow gash is present. Its length is about 12 mm. From the gash, for a width of 6 mm., a slightly concave slice has been pared from the surface of the bone to the termination of the broad end. There is no mistaking the interpretation of the evidence. The instrument with which the cut was made must have closed on the bone at a very low angle, and then part of the cutting edge skidded along the surface, taking with it a thin slice of the bone. Fig. 1, Plate XXXVII., brings us nearer the curved cuts seen on some of the described specimens, and it may be regarded as an intermediate stage between those specimens and Fig. 8, Plate XXXVI., just dealt with. We see in this example the work of the same instrument, only it has here cut the bone at a much more upright angle, and, consequently, a curved incision, 4 mm. in width, has been made across one corner of the bone to a depth of between 2 and 3 mm. The severance of the corner from the main part of the bone by a continuance of the cut would have yielded a form almost identical with Fig. 2, Plate XXXVII., in which a similar cut had passed obliquely through the bone. The evidence is conclusive that the bones have been operated on by some object capable of making a clean cut through as much as 7 mm. of solid bone, and we know of no implement possessed by the Australian aborigine with which this could be done. For the purpose of obtaining the marrow, man would most certainly smash the bones in the easiest way possible, as he does at the present day, and, apart from this, it is difficult to surmise what object led him to make these cuts, supposing he did so, for they fail to reveal any evidence that they were formed during the process of manufacture of any implement, weapon or personal ornament.

We therefore conclude that there is no evidence indicative of the fact that man took any part whatever in the creation of the remarkable cuts under discussion.

On the other hand, the information gained by a study of the whole of the specimens at our disposal tends strongly to support the conclusion that the work in question is that of a bone-eating animal, but it must be conceded that his jaws were immensely powerful, and his teeth capable of making cuts of a form that might well create a feeling of scepticism in regard to the existence of such a creature. As *Thylacoleo* is the only animal known possessing teeth anything approaching the description required, we have experimented with the idea of ascertaining whether it is possible to imitate the diversity of cuts and markings on the various described specimens, with the aid of the teeth of that beast. In this way, using modelling clay to represent the bones, we found that all those surface scorings which are sufficiently defined for us to be sure of their artificial origin could be duplicated by pressing different parts of the cutting edges of the teeth lightly on the clay. The chisel-like incisions, shown particularly in Fig. 2, Plate XXXVI., have their abrupt terminal ends very slightly bifurcated, and this feature was remarkably imitated—more prominently on account of the medium used—by the edge of the upper tooth, just where the anterior end commences its terminal curve.

If the great premolar were biting on a flat surface only two indentations would be made, one corresponding to each of the raised ends of the cutting ridges, but, on the curved surface of the bone in question, the whole, or at least the greater part, of the cutting ridge came into play, with the result that the surface of the bone is marked by long curved incisions.

Mention may be made of the scalloping very inadequately shown on Fig. 8, Plate XXXVI., and Figs. 1, 19, Plate XXXVII., to which reference has already been made in regard to Fig. 19, Plate XXXVII. On one corner of Fig. 1, Plate XXXVII., there are three tiers or steps of scallops made by cuts similar in form to the slight incisions on the surface of this and other bones—(indeed one of the chisel-like incisions is present on one of the steps)—but cutting more deeply into the bone substance. In other words, we have a series of cuts all of similar form, the slightest resulting in mere surface markings, others in more or less deep scalloping, and others, finally, in complete cuts through the bone.

Before passing on to make some general remarks, we may draw attention to one or two other specimens. The deeper straight impressions or gashes as seen in Figs. 10, 11, Plate XXXVI., although comparatively few in number on the Pejark specimens, are common on those from elsewhere to which we shall have occasion to refer later. In both specimens such gashes have apparently been the means of fracturing the bones at oblique angles

These cuts may be compared with those figured by De Vis (4), to one or two of which they are closely comparable. They are attributed by that author to the agency of *Thylacoleo.*

Some fragments show clear evidence of having been chewed after having, apparently, been broken off the main bone. In Fig. 17, Plate XXXVI., this is evident in the general rounding of the fragment and the consequent removal of about half of the external surface, showing the area exposed beneath covered with small incisions. Though the difference in the nature of the material renders the experiments of little value in certain respects, yet the result of treating a rounded surface made of modelling clay with the large premolars of *Thylacoleo* led to results of some interest so far as the shape of the cuts was concerned. In the case of the bone, the nature of the material introduces a factor that has doubtless much influence in deciding the ultimate form of the curve. The force used may, for example, produce first a cut of a certain curved form, and, beyond this and continuing the terminal line of the cut, it may form a fracture of varying length. This, we believe, is well shown in Fig. 7, Plate XXXVII., a narrow pointed fragment, one margin of which is convex, the other concave. The origin of the convex fracture is seen at its base, where there is unmistakable evidence of teeth having been forced into the bone from both sides. The concave side, on the contrary, bears no indication of the origin of the fracture. It may be due wholly to a fracture, or, what is more likely, the part of the broad end may be due to an incision which has been continued as a fracture to the pointed end.

Those forms selected for reference are, however, we think, free from this doubt, a strong point in their favour being the remarkable similarity in the curves of the three most striking specimens (Figs 4, 5, 6, Plate XXXVII.). Apart from those figured, it must be remembered that numbers of specimens down to some of the smallest in the collection, when carefully examined, reveal the fact that concave cuts have been made upon them. These are so constant and so frequent that we are safe in assuming that we are dealing with cuts and not with fractures. Not only are the examples numerous, but the specimens have been gathered from different places extending over a distance of one quarter of a mile along the bed of the old swamp.

It is very difficult to understand, even with the aid of such experiments as we were able to make, how certain of the cuts were produced. Other results obtained, however, were so close in their resemblance to the actual bone specimens that it seems certain that we are dealing with something more than a mere coincidence. By taking an impression of the cutting edge of both lower and upper teeth and comparing them with the curves of the specimens, they are seen to be very similar. For example, Fig. 3, Plate XXXVII., represents the impression made in clay by the hinder part of the cutting edge of the lower right premolar. If the curve of the cut edge in the model be compared with the same in Figs. 1, 2, 4, 5, Plate XXXVII., the likeness between them is striking.

Continuing the experiment, and cutting right through the clay with the tooth, the piece (Fig. 15, Plate XXXVII.) yielded by the inner side of the cutting edge is, so far as the curve is concerned, practically identical with the bone specimen (Fig. 16, Plate XXXVII.).

Other specimens again, especially those on which the cuts occur in series parallel to the length of the bone, are not sufficiently definite to give reliable results.

The concavities in Fig. 14, Plate XXXVI., and Figs. 17, 18, 19, Plate XXXVII., we quite failed to reproduce experimentally, and could only conclude that, as there is no good reason to doubt the identity of the agent of causation, and the concavities, as before mentioned, were not clear cuts, fracturing had largely influenced the contour in question. One of the concavities in Fig. 19, Plate XXXVII., especially supports this view, and might have been made by the rounded anterior end of the upper premolar, or by the formidable incisors. In connection with these, a feature in the large fragment (Fig. 1, Plate XXXVIII.) may be noticed. It is seen at one end of the specimen, and consists of a curved cut (a), through the cortex of the bone to a depth of about 3 mm., by which the cortex has been removed entirely between the cut and the fractured surface of the bone. Just close to this, and towards the more distant end of the specimen, a small concave piece (b) has also been taken out of the cortex to the same depth. The curve which forms the margin of the larger cut is in general agreement with that seen in Fig. 4, Plate XXXVII., but, so far as we can tell, it appears to have been made by the upper premolar, the anterior part of which for about 18 mm. fits remarkably well into the line of curvature. The curve must have been completed by a continued fracture. The small concavity (b) immediately behind the large curve (a) could easily be made by the anterior raised end of the cutting ridge of the tooth.

In Figs. 13, 14, Plate XXXVII., the obtuse angle, formed where the cut face (a) meets the edge of the bone (b), coincides with the angle (c) of the cutting ridge of the upper tooth

(Fig. 1A, Plate XXXIX.). Fig. 11, Plate XXXVII., represents the cut made in clay by the pressure of the upper left tooth, and it will be seen how closely the angle agrees with that of the actual bone specimen. In Fig. 14, Plate XXXVII., the edge (b) of the bone shows a fracture, but in Fig. 13, Plate XXXVII., which was apparently cut by the right upper tooth, both the cut surface (a) and the edge (b) are definite incisions.

Attention may here be drawn to the fact that, in the case of the upper premolar (Plate XXXIX., Fig. 1A), the cutting ridge is divided into two parts inclined at an open angle to one another, whilst, in the lower premolar (Plate XXXIX., Fig. 2A), the line of the ridge forms a continuous curve. Differences due to these facts are expressed in the more curved or slightly angular cuts made respectively by these teeth.

While the results of the experiments with clay have shed considerable light upon the problem we have attempted to solve, it is not held that they represent exactly what has taken place in the original operations. The difference in the nature of the material employed alone might lead to erroneous conclusions, owing to the modelling clay yielding so readily to pressure and simulating forms which perhaps would not be obtained if the natural material had been used.

Taken in conjunction, however, with the repetition of many general features and details in the specimens which we have been able to reproduce, the experiments certainly seem to bear out the assumption that *Thylacoleo* was, as far as it is possible to ascertain, the cause of the remarkable human-like sculpturing and fragmentary condition of the bones.

It should be mentioned that a careful examination of teeth-marks on bones convinced us that *Thylacoleo* had fractured some of them by a chopping action of its teeth directed on, or very close to, the same spot. A study of the surfaces of the specimens completely sliced without fracture reveals the fact that what appears at first sight in two or three cases—for example, Fig. 14, Plate XXXVII.—to be a face produced by a single continuous application of a cutting instrument, is really made up of several facets. In these instances it seems as if severance had been effected by this chopping action of the teeth on the bones, delivered at the same angle and in the same line.

It must be added that no indication of this character can be seen in most of the specimens. Such a method of working the bones would naturally not require anything like the great power necessary to force this animal's shearing teeth through bones of the thickness of those which have been operated upon.

A noticeable feature about all the cut bones, with possibly a very few exceptions, is that they appear to have been cut through by one tooth only, either the upper or the lower, as the case may be, there being no positive traces of marks of teeth on both sides of the bone or of the place where they met when severance took place. This may be associated with, and probably explained by, the fact that, with the exception of the one large piece (Plate XXXVIII., Fig. 1), all the specimens are fragments of hollow bones, and that, therefore, it is more likely that they were split by the pressure exerted in making the cuts, or maybe they were broken longitudinally by the beast after the transverse fracture had been effected.

Through the courtesy of Dr. Stirling, Director of the South Australian Museum, Adelaide, Mr. E. F. Pittman, Government Geologist of New South Wales, and Dr. Hamlyn Harris, Director of the Queensland Museum, Brisbane, we have been able to compare the tooth-marked bones found in those three States with the bones with which we have been dealing.

First, to take the bones from South Australia, which were collected from the bed of Salt Creek, Normanville, by Messrs. A. H. C. and F. R. Zietz, there is nothing of special interest to be noticed such as we find in the specimens we have described from Victoria. Nearly all the marks and cuts are what might well be expected to be produced by an animal possessing a shearing tooth like that of *Thylacoleo.* These incisions consist mostly of straight, blunt gashes crossing the bones more or less transversely; a few (Plate XXXVI., Figs. 3, 5) however, show the characteristic curve of those we have fully dealt with in describing the marked and cut bones from Pejark Marsh, but in no instance is there anything to be seen of a nature approaching the clean cuts right through the bone in specimens from Pejark, which bear so great a resemblance to the work of man. The bones are all fragmentary, being fractured both transversely and longitudinally. Some of those fractured longitudinally have undoubtedly been broken by the insertion of a pointed and not a shearing tooth, for the marks of a tooth of this character are plainly visible, which would mean, if *Thylacoleo* is the responsible agent, that his incisors were brought into play; otherwise we can only assume that some other of the contemporary carnivorous animals had also taken part in breaking and marking the bones. There is, however, as we have already stated, nothing in any of the features noted which cannot be satisfactorily explained by attributing them to some bone-eating beast or beasts such as we know existed along with the animals whose remains we have been discussing. These bones therefore do not call for further attention.

Some of the New South Wales specimens, which were found in a pleistocene deposit at Myall Creek, near Bingera, possess some points of interest. Their occurrence was described in detail by Mr. W. Anderson (1), and we quote the following from his report:—

"Occurring in the ossiferous portions of the clays were numerous small fragments of bones, generally a few inches in length, and chiefly pieces of the longer limb bones, which had been broken into fragments prior to their deposition in the clays. In almost every case the sharp fractured edges and angles of these fragments had been slightly rounded by attrition, but they were by no means so well water-worn as the pebbles which occurred along with them. The fragments of the thicker bones rarely showed an entire transverse section of the bone which had not only been fractured transversely, but also longitudinally. In the case of fragments of the thinner bones, the transverse section is generally complete, the bone not having been fractured longitudinally. The large majority of the broken fragments show unmistakably the teeth-marks of some carnivorous animal or animals. Most of these marks are, however, too fine to have been produced by the carnassial teeth of *Thylacoleo*, although there are some of them which seem large enough and coarse enough to have been so produced. The fragments of bones which show evidences of having been gnawed are chiefly pieces of the shafts of the longer limb-bones and ribs. The teeth-marks occur singly along the surface of the fragments, corresponding marks being often present on the opposite surface, indicating the action of the teeth of both jaws on the bones. Generally, however, the marks are confined to one or both ends of the fragments, which often bear evidences of having been bitten sharply off, while close to the sharply-bitten end the surface is furrowed with teeth-marks, showing that, whatever the animal was by the action of whose teeth the marks were produced, it had a similar habit to that which the dog and other carnivora possess, of holding one end of the bone on the ground between the fore-paws, while it gnawed the opposite free end. Few of the teeth-marked fragments of the bones belong to the skeletons of the larger animals whose remains occur in the deposit."

There is not much to add to what Mr. Anderson has said regarding the greater number of these specimens, and our remarks on the South Australian bones apply equally well to them. We might mention, however, that the marks stated by Mr. Anderson to be too fine to have been produced by the carnassial teeth of *Thylacoleo* are similar to those on the Pejark bones, only not so abundant, and which we have shown by experiment can be reproduced by pressure of the cutting edges of these teeth. The specimens of special interest to us from Myall Creek bear certain wedge-shaped gashes or notches which make them comparable to the Colongulac bone, and we defer a description of them until we deal with that specimen. As in the cases of the South Australian and New South Wales bones, the ones from Queensland are quite devoid of the interesting cuts exhibited by the Pejark specimens, but they differ from all the others inasmuch as, with one exception, they do not show the characteristic longitudinal fracturing. In the majority of cases the breaks occur straight across the bones, even in specimens of considerable thickness. Besides the fine markings and gash-like cuts, which are identical with those on specimens from elsewhere, there are present more or less rounded punctures or pits, and in several instances longitudinal cracks proceed from, and appear to be due to, them. Mr. De Vis (4) has figured and described some of these pits, and puts them down to the agency of *Thylacoleo*, a view with which we are in agreement. We mentioned that certain of the South

Australian specimens had been fractured lengthwise by the insertion of a pointed tooth, presumably the incisor of *Thylacoleo*, and these Queensland bones, cracked in a similar direction, strengthen the idea that much of the bone splitting has been accomplished by this means. It also gives some indication of the immense biting capabilities of the animal, which enabled it to force its incisors, modified to act as seizing and tearing teeth, into fairly solid bone far enough to cause its fracture.

It is rather puzzling to find that, while the bones from the three localities outside Victoria are marked generally with a similar type of incision, mostly in the form of a shallow gash, and distinct cuts of the Pejark type are entirely absent, the specimens from the latter place show very few shallow gashes, and cuts through the bone are comparatively plentiful. These differences in the character of the occurrences seem to point to the work having been done by teeth varying in the sharpness of their cutting edge, for it can be well understood that the shearing teeth of *Thylacoleo*, much worn down by usage, would be quite incapable of doing more than make a surface cut, or crushing the bone until it yielded to the pressure of repeated blows of the teeth, without leaving any well-defined slicing like that seen on the Pejark bones. On the other hand, it is possible, although improbable, that the Pejark specimens were softer, and did not fracture as the more brittle ones would do, but withstood the cutting action until they were completely cut through.

2.—The Buchan Bone.

Another bone, found by Mr. J. A. Kershaw, of the National Museum, Melbourne, bears cuts, the origin of some of which is a matter of doubt. The specimen was found in one of the several caves in the devonian limestone of Buchan, in Eastern Gippsland, which contained the remains of extinct marsupials, including a skull of *Thylacoleo*.

That the find was a genuine one is certain, for Mr. Kershaw, who visited Buchan purposely to collect material from the caves, was one of the first three to enter this particular cave in which the bone was found, and the ground had not been previously disturbed. The cuts were not noticed until the bones collected were being cleaned in the Museum. The bone itself Plate XXXVIII., Fig 2) is apparently the cylindrical part of the shaft of a kangaroo tibia, about five inches in length, and in the same fossil condition of all the bones of extinct forms occurring in the caves.

From the substance of the piece, it seems to belong to a kangaroo as large as, or larger than, the greatest of our existing species. At the small end of the bone, commencing almost at the extremity, and extending along the prominent longitudinal ridge in the form of a double scallop (a) and (b) for about 54 mm., there is a long, almost continuous cut, as if the surface had been sliced off. The first scallop (a) is very shallow, and the further one (b), which terminates somewhat abruptly, is about 3 mm. deep, measured from the top of the ridge. The part connecting the two scallops has apparently, for about 6 mm., not been touched at all, and the ridge for that distance still remains.

The side of the bone opposite to these cuts has been gnawed for its whole length by some small rodent, such as a rat, the marks of both upper and lower incisors being perfectly distinct, but with these, which may have been added at a recent time, we do not propose to deal.

In order to compare the cuts with those which might have been made by *Thylacoleo*, a clay model approximating the bone in question was prepared, and a slice was cut from its side by the upper shearing tooth attached to a piece of the skull, taken from the cave in which the bone was found.

The resemblance of the contour of the cut so produced, when viewed from the side, to that on the bone is so remarkably close that it seems almost beyond dispute that they were both made by the same means.

The measurements, as nearly as they could be taken, agreed; and a groove corresponding to one formed by a ridge on the anterior external surface of the tooth was plainly visible in the corresponding position. The only difference noticed was in the abrupt termination of the cut made in the clay model by the posterior end of the tooth, and this might be accounted for by the depth of the cut being greater than the one on the bone, which is not quite continuous, and gives the impression that the bone was gripped by the tooth in such a way as to leave an untouched part opposite the concavity in the external surface of the tooth.

If such an explanation is deemed unsatisfactory, there can only be one alternative—that is, that it was the work of man, for there is no indication that the cut was made by any natural agency.

The Buchan bone fails to convey any idea that the cut was made to serve any useful purpose whatever, although it is conceivable it might have been incidentally caused in chopping flesh off the bone with a stone axe, a procedure most unlikely, not only on account of it being a practice not adopted by the natives, but also because the flesh on that part is a negligible quantity.

As in many caves, the bones found at Buchan appear to be odd, scattered and often fragmentary, nothing like a complete skeleton of any kind having been discovered. Also, in a number of cases, they show tooth marks of animals which have been gnawing them.

It is improbable that the herbivorous animals whose remains were found in the caves would frequent places where their natural enemies would be encountered. Moreover, the larger forms could not possibly have entered most of the caves by the present openings; hence, if they obtained admittance, or fell in, or if their bodies were washed in, it must have been through pre-existing entrances. The occurrence of the bones precludes the acceptance of the last view, although there is evidence that this particular cave was formed from what were at one time two distinct caves, as the remnants of a false roof made up of material originally deposited on the floor of an upper cave, are still to be seen. It is possible in this case that the complete remains of animals which may have fallen or been washed into the upper cave through an opening now closed were precipitated into the lower one when the false roof collapsed, thereby breaking and scattering the bones. In all probability most of the remains were originally carried into the caves by predatory beasts, and there eaten and gnawed.

The Australian aborigine as we know him, though we do not know whether he differs materially in being more superstitious than his predecessors, has usually the greatest repugnance to enter such dark and uncanny places as caves, let alone utilise them as places of residence and refuge. The so-called cave drawings that have often been described, are usually made on the walls of comparatively shallow excavations at the base of cliffs to which the term rock-shelter rather than cave is applicable. If, then, he has not changed, he has never been strictly a cave dweller, and certainly nothing has yet been discovered of sufficient importance which could in any way support a contrary opinion. There appears to be, so far as we know at present, an entire absence of his work and implements, which are so commonly found in the caves of Europe in association with the remains of extinct animals. We can only conclude then, in view of the absence of definite proof that man was at any time an occupant of the cave in which the Buchan bone was found, that the cuts were made by *Thylacoleo*.

3.—The Colongulac Bone.

The bone, to which we have applied the above title, was presented to the National Museum, along with other specimens in 1909, by Mr. A. D. Hardy, F.L.S., an officer of the Forests Department. Mr. Hardy informs us that they were unearthed from a low mound near the south-eastern end of Lake Colongulac, near Camperdown, in the south-west of Victoria, by the late Mr. Wm. Adeney, who owned the Chocolyn estate about 1847-48. They passed into the hands of his nephew, Mr. Day, an officer of the Lands Department, who gave them to Mr. Hardy, and he almost immediately presented them to the Museum.

Lake Colongulac (formerly also known as Lake Timboon) is the most interesting of Victorian localities where mammalian remains have been found. The geology of the neighbourhood, including some notes on the occurrence of remains, has been briefly dealt with by Dr. T. S. Hall[1], and a more comprehensive report in "The Geology of the Camperdown and Mount Elephant Districts" was made by Messrs. H. J. Grayson and D. J. Mahony.[2] No bones have been found *in situ* as far as

1. Proc. Roy. Soc. Vic., vol. xii., pt. I, pp. 107-111, 1889.
2. Memoirs Geol. Survey of Victoria, No. 9, 1910.

we are aware, those found having been picked up on the shores of the lake, but there is no doubt, like those of Pejark Marsh, that they were originally deposited in a swamp or lagoon, which was afterwards buried under the ashes ejected by the neighbouring volcanoes; the bones, in this instance being subsequently freed by the breaking up of the bed, and cast upon the shores of the lake. In consequence of the bones not having been found *in situ*, we do not know whether the animals died where the bones occurred in the original bed, and left their skeletons in a complete condition, or whether the bones were fragmentary from being washed into the lake or lagoon, or broken up in the manner of the Pejark bones.

We were at first strongly of the opinion that the cuts on the Colongulac bone are of such a nature that they might with considerable certainty be attributed to man; but, after careful consideration of the bone and comparison with other specimens, referred to later, we realised the possibility of their having been made by some other agency, more particularly as some of the cut bones from Pejark Marsh, without collateral evidence to the contrary, would without doubt be put down to the work of man.

The bone (Plate XXXVIII., Figs. 3, 3A) consists of the distal portion of the 4th metatarsal of a large extinct marsupial, probably of *Palorchestes*, though it is too imperfect to identify definitely.

It seems as if an attempt had been made to sever the articular head from the shaft by means of two deep, wedge-shaped notches extending a little more than half way across the bone. The upper surface of each is at right angles to the longer axis of the bone; the lower faces slope upwards from the margin to meet the former. The greatest width of one notch is approximately 12 mm., and that of the other 10 mm. Where the two notches are confluent on the margin of the bone, the latter has been penetrated to a depth of about ·6 mm. The notch on the dorsal surface is, as nearly as can be measured, 10 mm. in depth, compared with 6 mm. in the case of the ventral one.

As the bone was found some 45 years before it came into the possession of the Museum, the doubt arises as to whether these cuts were made since its discovery.

When, however, the bones were received by us, they nearly all, including the one under discussion, had some of their matrix adhering to them, and it was only after cleaning the specimen that the true nature of the notches became evident. The whole surface shows the effect of age; the cuts, especially, instead of being smooth as new cuts would be, are more or less corroded. Again, on part of the surface of the bone there is a strongly adherent coating of calcium carbonate, which has in one place entered a notch and covered a portion of it. The notches have either been produced by man or by the teeth of some especially powerful animal. In the latter case, it is difficult to realise how the work could have been done without severing the head from the shaft. That this would have been the result of continued pressure of a wedge-shaped tooth is certain, so that the notches must be due, whatever the agent may have been, to a series of blows given in like manner that an axe is used by man.

We have previously mentioned that a study of some cuts apparently made by *Thylacoleo* leads us to believe they were produced by a similar chopping action with his premolars. The notches, however, are more particularly suggestive of human workmanship, but we are faced with the objection that we know of no instance in which Australian man has severed bones in such a manner, or, indeed, in which he has cut bones at all comparable to any of those described in this paper. The usual method seems to have been to simply break the bone transversely, or even longitudinally, by blows from a blunt implement, and subsequently, by grinding, to fashion from the piece of bone thus prepared the desired article. The consequence of this procedure is that all the bone implements we have examined where only one end has been ground, either showed the head of the bone untouched, or else the original jagged fracture without modification, in cases where the head has been removed. It seems scarcely likely, when such a simple and rapid operation accomplishes all that is required, that the prehistoric Australian native would resort to the laborious and lengthy business of chipping through a tough bone of fair substance with a stone implement in order to separate the head from the shaft, with the object of afterwards employing the latter in the manufacture of some implement or other article. We are, therefore, of the opinion that, notwithstanding the very strong resemblance to man's work exhibited in the Colongulac specimen, it is not sufficient in itself to allow us to assert that man actually made the cuts; and the notes following on some of the tooth-marked bones from Myall Creek, N.S.W., materially support this view.

We stated previously that these particular specimens from Myall Creek bear wedge-shaped gashes which make them comparable with the Colongulac bone, and this fact considerably discounts what seemed almost a certain belief, that the latter bone received its cuts from the hand of man. Strangely enough, two out of the three bone fragments which exhibit this feature are, like the Colongulac bone, apparently parts of the 4th metatarsal of an extinct marsupial of about the size of *Palorchestes,* only in those two cases we have the proximal and not the distal half of the bones. The better of these two specimens is illustrated in Figs. 4, 4A, Plate XXXVIII. The bone is fractured longitudinally from end to end, but the side view shows the natural surface with the short transverse gashes round one end of it, resembling the impressions left by blows from a blunt tomahawk. The wedge or V-shaped cuts, two of which are seen in Fig. 4 at (a) and (b), occur beyond the transverse cuts at the extreme end of the bone. On the other side of the specimen, exactly opposite to (a), the larger of the two cuts, a third one, (c), the largest gash of all, penetrates the bone almost sufficiently deep to meet the cut (a). The end view (Plate XXXVIII., Fig. 4A) shows the characteristic wedge-form of the three cuts (a, b, c), and also the resemblance, on a reduced scale, that they bear to the Colongulac bone.

The difference in the two instances is that, in the latter, the cuts are transverse, whereas in the Myall Creek specimens the cuts are longitudinal.

There can be little doubt that the V-shaped cuts in the Myall Creek bones were made by the animal whose gnawing of the bone has left prominent evidence, in the number of short transverse gashes round the end of this and other specimens. We have, in *Thylacoleo*—for to him must be accredited all the cuts in question—an animal capable of producing by means of his shearing teeth cuts bearing a striking resemblance to the notches made by civilised man in severing certain materials with the aid of a knife or axe. There is admittedly, as regards size. a great difference between the Myall bone and the Colongulac bone, and moreover, in the latter instance we have no corroborative evidence of the work of *Thylacoleo* in the presence of markings or cuts of any kind which might safely be attributed to him. At the same time it throws much doubt upon what might otherwise unhesitatingly be accepted as the handiwork of man, more especially when we know that that work is not of a nature practised by the natives of Australia in historical times.

Literature consulted on *Thylacoleo carnifex*, Owen.

1. Anderson, W.—"On the Post-Tertiary Ossiferous Clays near Myall Creek, Bingera." Rec. Geol. Surv., N.S.W., Vol. I., 1889-90, p. 116.
2. Broome, R.—"On the Affinities and Habits of *Thylacoleo*." —Proc. Linn. Soc., N.S.W., Vol. XXIII., Part I., 1898, p. 57.
3. Cope, E. D.—"Ancestry and Habits of *Thylacoleo*."— American Naturalist, Vol. XVI., 1882, p. 520.
4. De Vis, C. W.—"Bones and Diet of *Thylacoleo*."—Annals of the Queensland Museum, No. 5, 1900, p. 7.
5. De Vis, C. W.—"Remarks on a Fossil Implement, and Bones of an Extinct Kangaroo."—Proc. Roy. Soc. Vict., Vol. XII., Part I., 1899, p. 81.
6. De Vis, C. W.—"On Tooth-Marked Bones of Extinct Marsupials."—Proc. Linn. Soc., N.S.W., Vol. VIII., 1883-4, p. 187.
7. De Vis, C. W.—"On a Femur, Probably of *Thylacoleo*."— Proc. Roy. Soc., Queensland, Vol. III., 1886, p. 122.
8. Falconer, Hugh—"On the Disputed Affinity of the Mammalian Genus *Plagiaulax*, from the Purbeck Beds."— Quart. J. Geol. Soc., Vol. XVIII., 1862, p. 348. (Reprinted in "Palaeontological Memoirs and Notes," Vol. II., 1868, p. 430.)
9. Flower, W. H.—"On the Affinities and Probable Habits of

the Extinct Australian Marsupial, *Thylacoleo carnifex.*" Owen.—Q.J.G.S., Vol. XXIV., 1868, p. 307.

10. Krefft, G.—"On the Dentition of *Thylacoleo carnifex.*"—Ann. and Mag. Nat. Hist., 3 S., 1866, Vol. XVIII., p. 148.
11. Krefft, G.—"'A Cuvierian Principle in Palaeontology Tested by Evidences of an Extinct Leonine Marsupial (*Thylacoleo carnifex*), by Prof. Owen, F.R.S.'—Reviewed by Gerald Krefft." Ann. and Mag. Nat. Hist., 4 Ser., 1872, Vol. X., p. 169.
12. Krefft, G.—"Australian Natural History."—Trans. Roy. Soc., N.S.W., 1873, p. 135.
13. Lydekker, R. (Nicholson and Lydekker).—"Manual of Palaeontology," Vol. II., 1889.
14. McCoy, F.—"Prodromus of the Palaeontology of Victoria," Decade III., 1876.
15. Owen, Richard—"Researches on the Fossil Remains of the Extinct Mammals of Australia," 1877.
16. Owen, Richard—"On the Fossil Mammals of Australia, Part I.—Description of a Mutilated Skull of a Large Marsupial Carnivore (*Thylacoleo carnifex*, Owen), from a Calcareous Conglomerate Stratum, Eighty Miles S.W. of Melbourne, Victoria."—Phil. Trans. Roy. Soc., Lond., Vol. CXLIX, 1859, p. 309.
17. Owen, Richard—Ibid, Part II.—"Description of an Almost Entire Skull of *Thylacoleo carnifex*, Owen, from a Fresh-water Deposit, Darling Downs, Queensland."—Ibid, Vol. CLVI., 1866, p. 73.
18. Owen, Richard—Ibid, Part IV.—"Dentition and Mandible of *Thylacoleo carnifex*, with Remarks on the Arguments for its Herbivority." (Entitled in reprint, "A Cuvierian Principle in Palaeontology Tested by Evidences of an Extinct Leonine Marsupial"; see Krefft).—Ibid, Vol. CLXI., 1871, p. 213.
19. Owen, Richard—"Additional Evidence of the Affinities of the Extinct Marsupial, *Thylacoleo carnifex*, Owen."—Ibid, Vol. CLXXVIII. (B), 1887, p. 1.
20. Owen, Richard—"On the Affinities of *Thylacoleo.*"—Ibid, Vol. CLXXIV., pt. 2, 1883, p. 575.
21. Owen, Richard—"Pelvic Characters of *Thylacoleo.*"—Ibid, Vol. CLXXIV., pt. 2, 1883, p. 639.

EXPLANATION OF PLATES.

[All figures nearly natural size].

Plate XXXVI.

Fig. 1.—Clay model, showing incisions made with the upper and lower premolars of *Thylacoleo.*

Fig. 2.—Section of the head of a femur, showing fine chisel-like incisions. Pejark Marsh.

Fig. 3.—Piece of a limb bone, with curved incisions. Salt Creek, Normanville, S. Australia.

Fig. 4.—Fragment of bone, with straight incisions. Salt Creek, Normanville, S. Australia.

Fig. 5.—Longitudinal sectional of a calcaneum, with curved incisions, and a serrated edge where a pointed tooth has penetrated and split the bone. Salt Creek, Normanville, S. Australia.

Fig. 6.—Shaft of a metatarsus, with curved incisions made by the lower premolar of *Thylacoleo.* The end where they occur has been fractured transversely by means of one of these incisions, as seen by the similarity of the curves. Queensland.

Fig. 7.—Small fragment fractured by a curved incision, like that of Fig. 6. An incision having a similar curve occurs close to the fracture. Pejark Marsh.

Fig. 8.—Small piece of large limb bone, showing how a tooth has penetrated the bone to a slight depth, and then pared off its surface in a broad shallow groove. Pejark Marsh.

Fig. 9.—Gash incisions. Salt Creek, S. Australia.

Figs. 10, 11.—Gash incisions. The oblique terminal fractures are evidently due to such incisions. Pejark Marsh.

Fig. 12.—Proximal phalanx of the 4th toe of a large extinct kangaroo, showing a piece broken away by the entry of a pointed tooth, leaving thereby a jagged edge. Pejark Marsh.

Fig. 13.—Longitudinal section of the underside of a phalanx similar to Fig. 12. Pejark Marsh.


13
10
17
14
11
12
7
16
15
4
3
2
8
6
9
5
1